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The Cryosphere Discussions

Interactive comment on "Snow specific surface area simulation using the one-layer snow model in the Canadian LAnd Surface Scheme (CLASS)" *by* A. Roy et al.

Anonymous Referee #1

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Review of "Snow specific surface area simulation using the one-layer snow model in the Canadian LAnd Surface Scheme (CLASS)" by Alexandre Roy et al., submitted for publication in The Cryosphere.

SUMMARY, MAIN POINTS, AND RECOMMENDATION

This manuscript presents an offline model for the temporal evolution of snow specific surface area (SSA), driven by meteorological data from five sites in Canada and France. The offline model is incorporated in the CLASS one-layer snow model that has widely been used in climate models.

Research into SSA evolution has exploded in recent years, and the research presented

here is an interesting, albeit somewhat unusual approach to finding a simple way to incorporate SSA evolution in an existing snow model. The subject is appropriate for The Cryosphere, a journal that is evolving as a main platform for SSA-related research.

As I mentioned above, I find the chosen approach somewhat unusual. The few attempts to incorporate SSA evolution in the literature use multi-layer models (Lawrence, 2010, Kuipers Munneke 2011). There is an obvious reason for this: SSA evolution depends on local temperature, local density, and on local temperature gradients (Flanner and Zender, 2006). This is easily taken into account in a multi-layer model. The incorporation of an SSA model in a single-layer snow model is thus a bit odd. Indeed, the authors have to make quite a few assumptions to knit a multi-layer SSA model to a snow model in which crucial parameters like temperature are only known in one level. To me it seems that the authors have made it a bit difficult for themselves by sticking to a single-layer model, rather than taking one of the many multi-layer snow models that are around in this study field (Bartelt 2002, Bougamont 2005, Ettema 2010, Niwano 2012, CROCUS) and implement it in CLASS.

From what I understand, the motivation for developing this simple offline model is to be able to assimilate passive microwave brightness temperatures in CLASS to improve estimates of snow parameters. It is however unclear to me how this assimilation is going to be carried out. What quantities are assimilated and how will a single-layer snow model benefit from this assimilation? Plus, what is the specific role of SSA in the assimilation procedure? Perhaps, the authors have good reasons to use the CLASS model in particular, but this is not apparent in the manuscript.

On the other hand, the authors find good agreement between simulated and observed SSA at five study sites (except for wet snow conditions). Moreover, the authors are to be commended for their careful and extended discussion of potential model errors and implications of certain assumptions for the model results (section 4).

All in all, I get the impression that this model was developed with a rather specific

application in mind. I think it is ok to publish the model separately from any (future) application, but then the model paper should set out with a clear motivation about the approach that is adopted. At the moment, I have no clear picture of why this project was carried out in the way it was done. I would recommend to rewrite the manuscript in such a way that the motivation for this study becomes apparent to the reader, and in fact a central driver for the development of the model. This likely constitutes quite a major overhaul of the paper. On the other hand, after such a rewrite of the manuscript, it will serve as a perfect launching pad for future papers about the assimilation studies that will be carried out by it.

Finally, I think that section 4 would benefit from some more structure, and perhaps some more subheaders to allow for easier reading.

MINOR POINTS

page 5258 line 23: this part is not clear. What is meant by "In the case of the density correlation"?

page 5262 equation 4: I have the feeling that this equation is cast in an odd form. Why not

SSA(t+dt) = SSA(t) + Delta SSA(t+dt) ?

page 5269, line 8: Would it not have been possible to include a very simple thermodynamical scheme in the multi-layer SSA model to calculate a realistic temperature profile? This is one of the issues why I do not really understand why not a more complete multi-layer model was used. Thermodynamics is really only a diffusion equation plus a source term in case of refreezing: such an implementation would have taken away the need for the rather crude assumption of a linear temperature profile.

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